CENTRAL INTELLIGENCE AGENCY

INFORMATION REPORT

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1. The Germans at NII 49 in Leningrad were placed in a loose organization called the Specialist Group. This group was headed by Dipl. Ing. Herbert Mummert. It consisted of 21 Germans in five sections. /The organizational chart of NII 49 is given on page 5 of this report./

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2. [redacted]

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3. [redacted] the lead angle computer (Vortaltrechner) for the Rheintochter [redacted]

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[redacted] /For the technical description and diagrams of the computer see, pages 6-9 of this report./

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4. [redacted] the redesign of the Wasserfall parallax computer to accommodate Soviet components. This took place over a period of several weeks in 1947. There was actually little change made in the computer. The Soviet tubes required only small changes in cathode resistor values.

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5. [redacted]

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6. The initial control computer: This appeared to be the major project accomplished by the Germans at NII 49, in that a high order of technical improvement was made, and that the Soviets were extremely interested in Wasserfall. In 1947, the group adjusted and tested the original computer made at Kreiselgeraete, Berlin-Koeppingen. These tests revealed errors as high as 15 degrees.

7. The purpose of the initial control computer (Einlenkrechner) was to steer the missile in the first few seconds of flight into the view of the ground controller. This was done by receiving the target angle continuously, and calculating the desired time history. When the missile came into view of the ground controller operating the Kneuppel (jogstick), he would take over and change the path of the missile according to the angular error between the target and the missile.

8. The computer for Wasserfall was taken over by the Soviets in August 1948. [redacted] 25X1 the Soviets were extremely interested in Wasserfall because of the continued insistence on perfection in the computer.

9. The initial trajectory computer operated as an analogue of the following equation:

$$\ddot{\gamma}E + \frac{t-6}{24}\left[f\,(\gamma E - \gamma Z) + \gamma E + \gamma Z\right] = 0$$

[It should be noted that with the assumption that γZ is a constant, and that the time is at least six seconds after firing, then the equation reduces to a simple second order differential equation. This is typical of a simplified dynamic equation describing the correction in error from a moving beam. Automatic control of the missile itself could be done simply by having rudder displacement proportional to the output of the computer.]

10. The initial trajectory computer [as described on Pages 12-15.] was an improvement in the original design because of higher precision components. Tests showed that the actual path with the improved computer was much closer to the predicted path, being within one degree of the desired curve. It should be noted that this is a measure of the performance of the computer against the desired output, not the missile performance. In other words, the equation above represents the desired relationship between γE and time. The computer gives an analogue solution which is accurate to within one degree. There was never an opportunity to test this computer in a missile. The improvement in performance can be shown by comparing the maximum error of the original one designed in Germany during the war. This had errors as high as 15 degrees.] There was continual improvement

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on the Wasserfall initial trajectory computer from August 1948 to September 1951.

25X1 11. Wasserfall parallax computer: [redacted] negative feedback amplifier. This amplifier could be considered more an impedance matching network than an amplifier, and was standard. It should be noted that it included an auxiliary feedback loop to the plate of the 6J7 to compensate for the main feedback loop at higher frequencies. /A diagram of this amplifier is included on Page 16 of this report./

25X1 12. Three-dimensional cam (Kurvenkurper): [redacted] The project engineer was LANGENBACH, chief of the Design Section. The cam was supposed to replace the computer described above /in paragraph 3/. The principle of operation is as follows:

a. Through linkages and cam followers, representing the input of γZ and the output of γE, and a three-dimensional cam rotating a constant speed, the computation carried out by the computer described above /in paragraph 3/ would be duplicated. This research was accomplished in 1949, but was dropped after a few months because of the expense in production. The cam required 12,000 man-hours to produce against the 3,000 man-hours that were required to produce the electro-mechanical computer. /A simple sketch, representing the general appearance of the cam, is given on Page 17 of this report./

13. Tau-angle computer (bank-angle computer): This is a device which, in effect, coordinates the rolling axis in climbing turns. With reference gyroscopes rotating in the airframe axes, it can be shown that in a climbing turn the rate of bank must be proportional to the desired rate of turn multiplied by the sine of the climb angle. The German group designed a computer to satisfy the equation shown on one of the sketches /Pages 12-15 /. Since the Wasserfall missile did not roll, this computer was to be used then, in conjunction with the command system, to resolve the turn and climb control signals, and apply the components to turn and climb controls of the missile to prevent reversal of controls. [redacted] 25X1 it was a project of Mr. NUERNBERG, who later tested it on a turntable, and [redacted] 25X1 it was generally considered satisfactory.

14. Research to eliminate tachometers: In order to stabilize the different servo systems utilized in the Wasserfall computers, tachometers were generally used. Because of the lack of German tachometers (velocity generators), and the large size of the Soviet tachometers, some research was carried out by the group to eliminate the necessity for tachometers in the design of their equipment. For systems using alternating current throughout, a double T-network, copied from the Franklin Institute Journal circa 1947, was successfully used. [redacted] 25X1 no adequate tests were

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[redacted]

25X1 made. [redacted] use of the phase advance "notch filters" did, in fact, stabilize the servo systems required within his capabilities of observation. Since this work was to be done using 50-cycle equipment, use of alternating current "notch filters" would tend to be more satisfactory than at 500 cycles.

15. Sine wave generator: A mechanical sine wave generator was built as test equipment for computer and gyroscope equipment. 25X1 [redacted] this method of producing rates and accelerations more reliable than that obtainable through electrical means. A constant speed motor driving an ordinary lever arm produced a sine movement through a yoke arrangement.

16. Toroidal coil winder: This was a project in the Design 25X1 Section under LANGENBACH [redacted] 25X1 [redacted] it could be used to wind toroidal coils 25X1 from one inch to six inches in diameter. [redacted]

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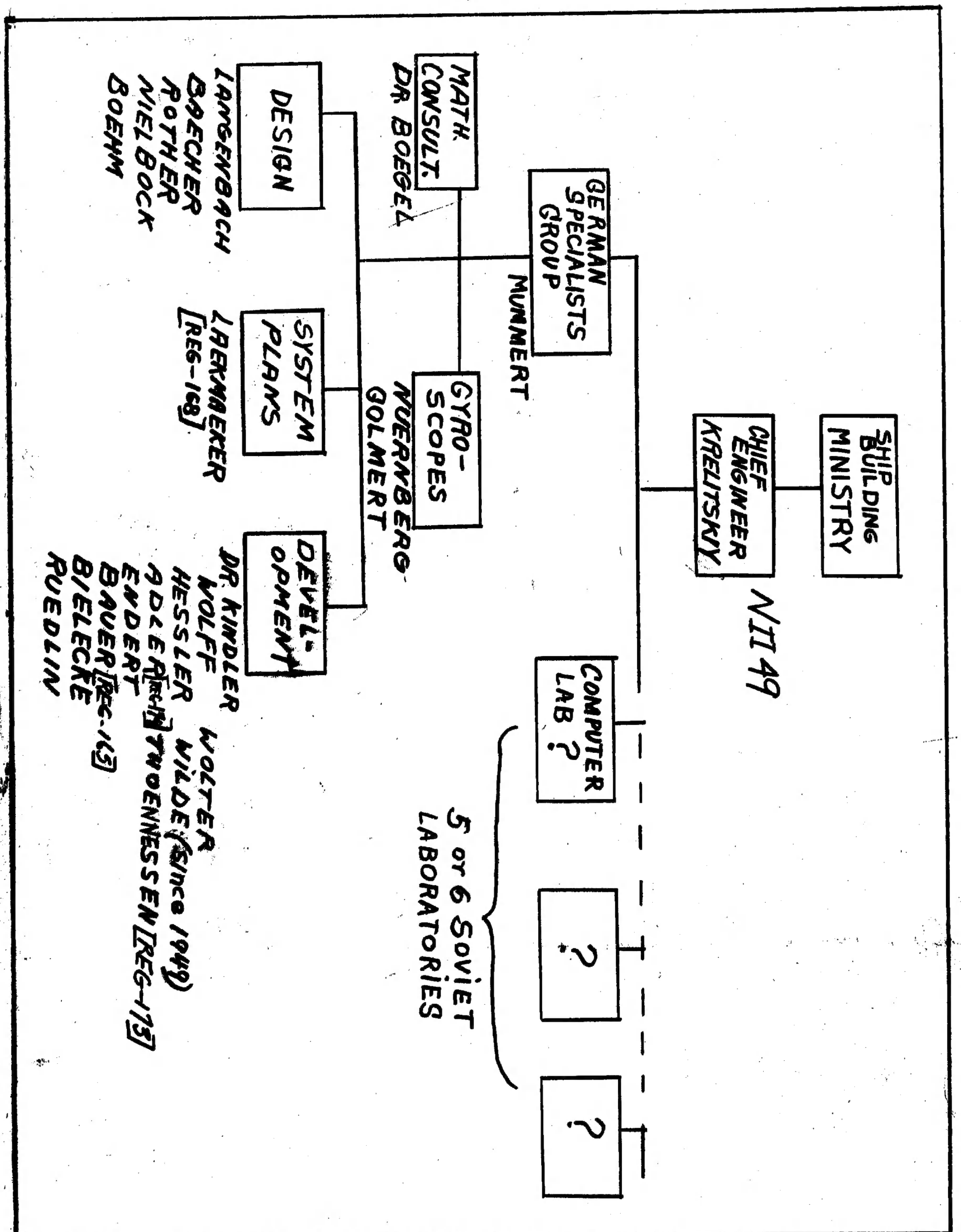

Organization Chart Of NII 49

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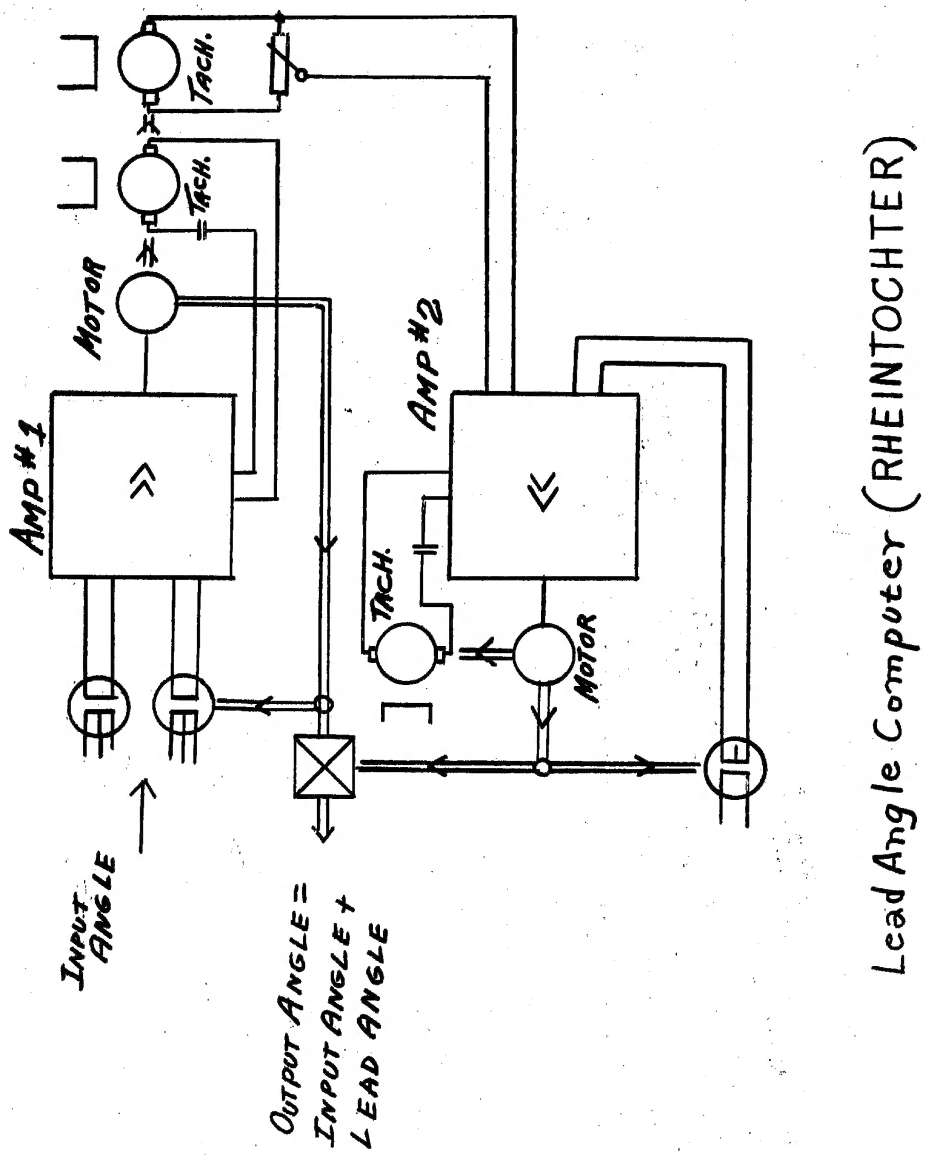

DIAGRAM 1

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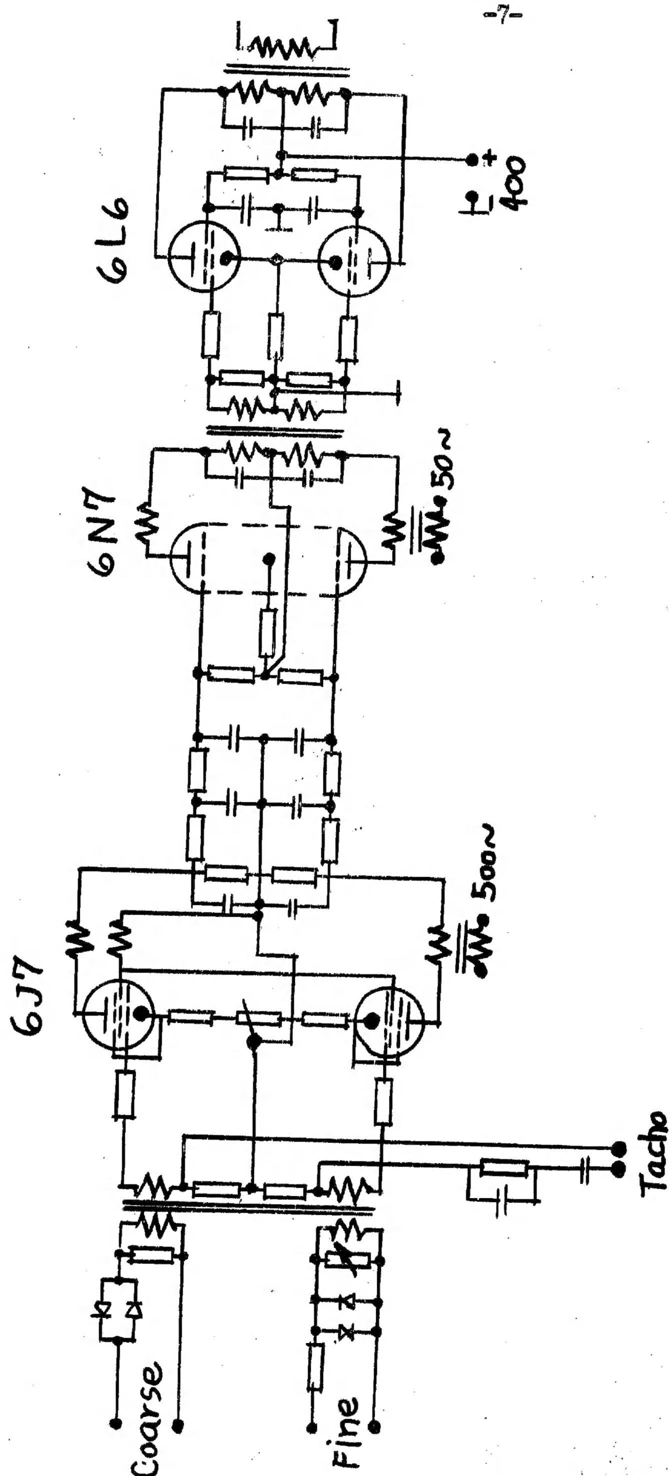

AMPLIFIER #1 (VR-7) LEAD ANGLE COMPUTER (RHEINTOCHTER)

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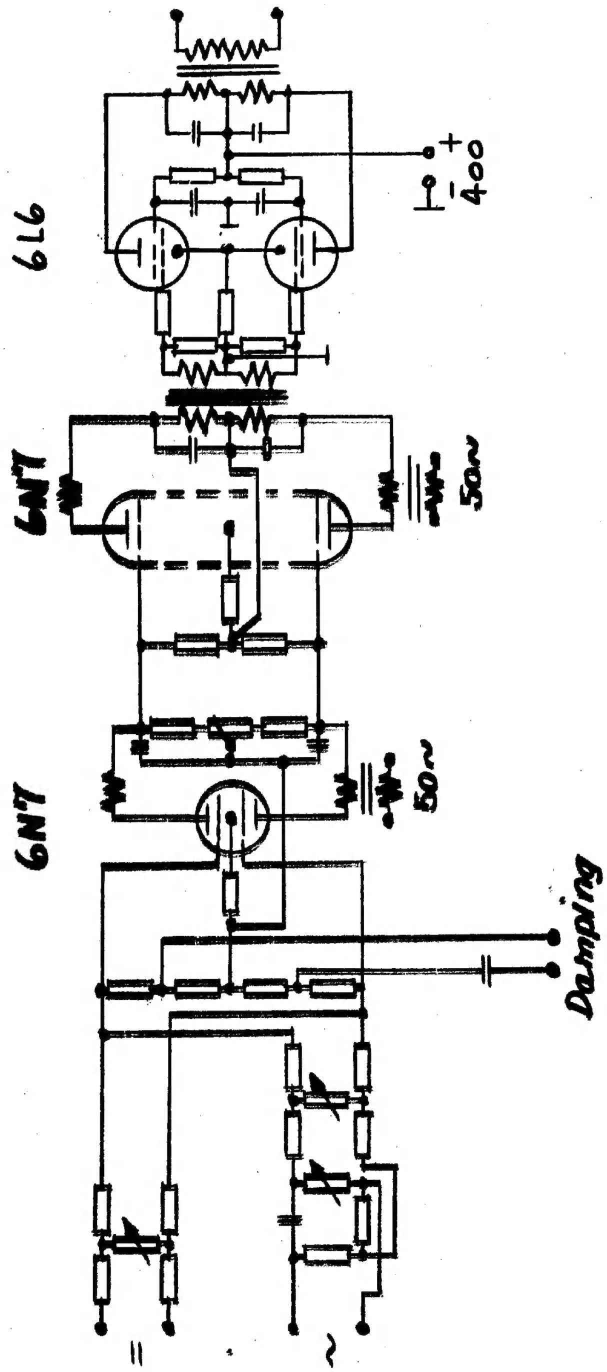

AMPLIFIER #2 (VR-12) - LEAD ANGLE COMPUTER
(RHEINTOCHTER)

DIAGRAM 3

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Legend to diagram Nos. 1, 2, and 3

Technical Discussion of the Reintochter Lead Angle Computor (Vorhaltrechner)

1.

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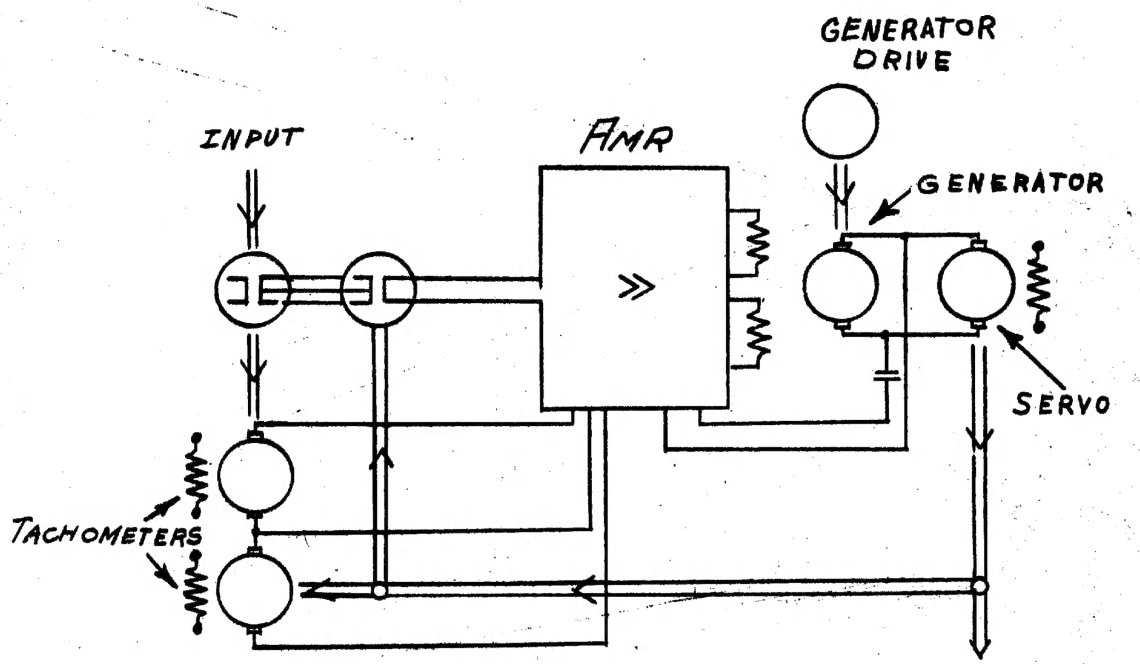
2. In order to control the Rheintochter missile, the operater was furnished with not only the azimuth and vertical angles, but also lead angles proportional to the rate of change of the target angles and distance.

3. In Diagram No. 1 [shown on Page 6] is shown a block diagram of the revised lead angle computer. It should be noted that the input angle is applied from the sighting device by a coarse and fine system. Tachometric feed back is used in the amplifier to obtain stability. A voltage proportional to the rate of change of input angle is obtained from a tachometer and applied to the second amplifier. The output of the second amplifier is added to input angle to furnish the desired output angle.

4. In Diagram No. 2 [shown on Page 7] is a circuit diagram of amplifier No. 1. The coarse and fine input signals are applied through a varistor arrangement to the input transformers to the 6J7 tubes. A 500 cycle voltage is applied to the plates of the 6J7 tubes, whose output is filtered and applied to the 6N7 tubes. The output of the 6N7 is applied to the 6L6 power amplifiers, which operate the servo motor. The servo motor is a two-phase induction motor. A tachometer, mechanically connected to the servo motor, is used to furnish velocity feed back to the grids of the 6J7 tubes.

5. Amplifier No. 2 (shown on Page 8] is used to furnish an angle proportional to the input angle velocity. A DC tachometer is used to furnish an input to the 6N7 amplifier tube. A 50 cycle voltage proportional to the error is produced by the first 6N7 and applied through the second 6N7 to the 6L6 power amplifier. A two-phase induction motor is used for the servo. Connected to this motor is a DC tachometer which is used for velocity feed back to the grids of the first 6N7 tube. An AC follow-up voltage is also applied to the 6N7 tube through a phase shift network to correct differences in phase between the supply voltage and the output of the follow-up selsyn. The outputs of Motor No. 1 and Motor No. 2 are added in a differential gear arrangement to furnish the desired angle.



Block Diagram Of The 2KW Ward-Leonard Servo System

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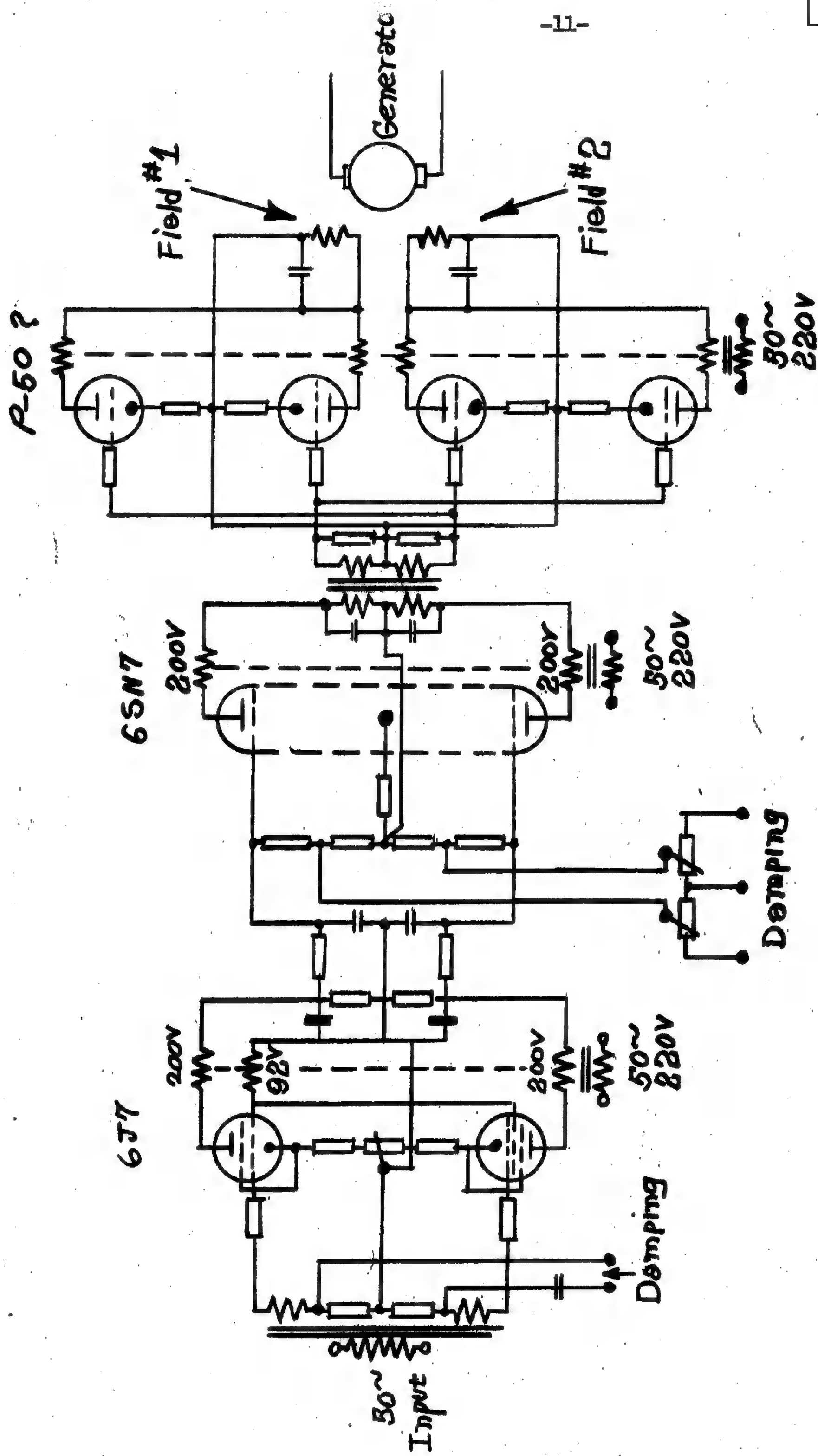

2 Kw Ward Leonard Servo Amplifier

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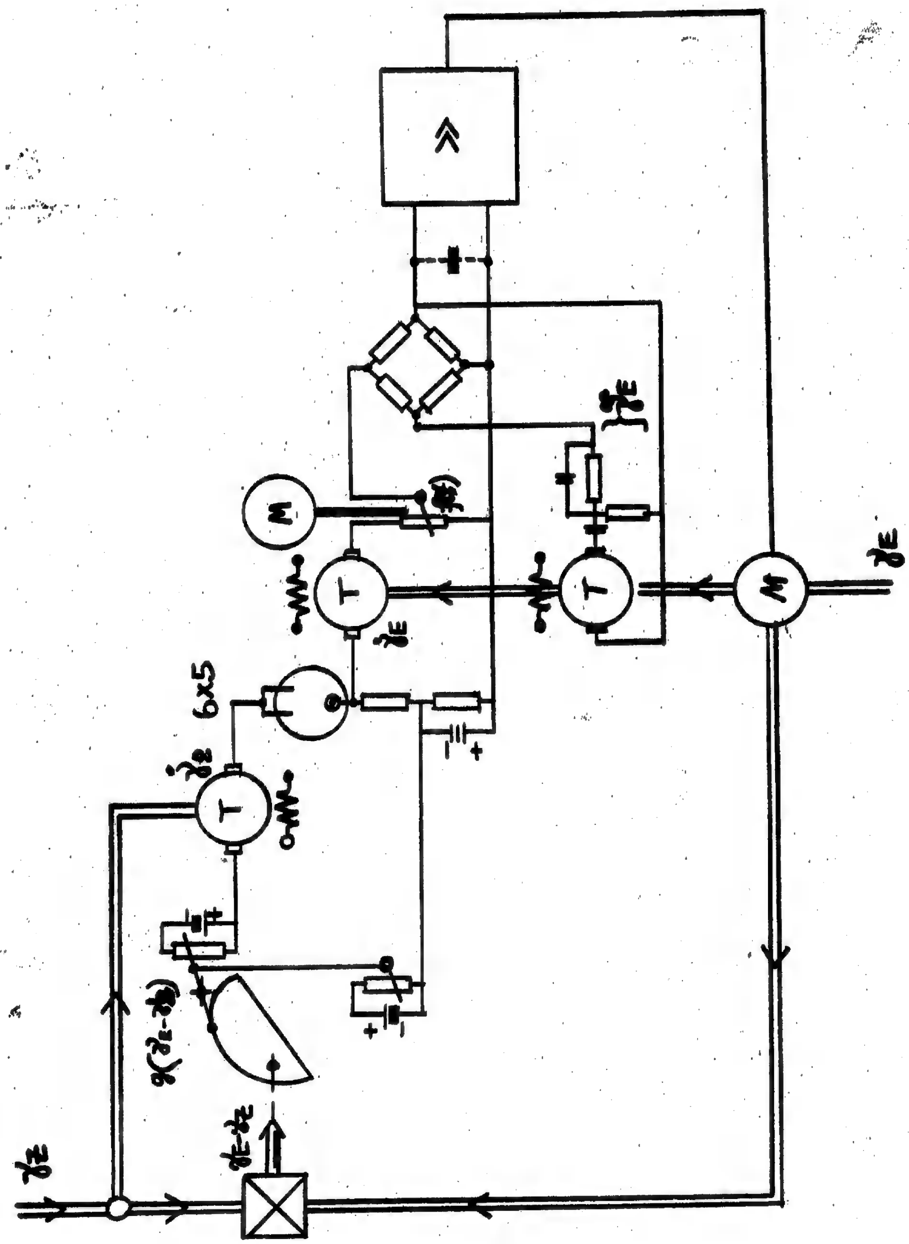

Initial Control Computer – WASSERFALL

DIAGRAM 1

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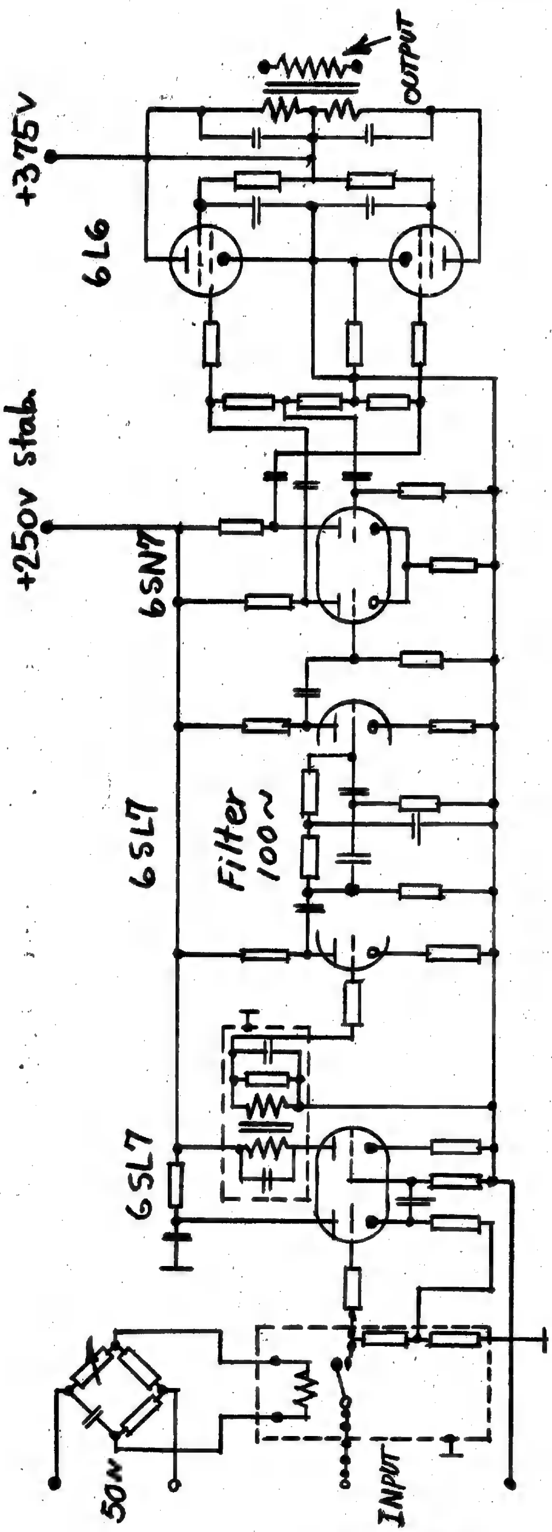

AMPLIFIER - INITIAL CONTROL COMPUTER - WASSERFALL

Diagram 2

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Technical Discussion of the Initial Control Computer (Einlenkrechner) for the Wasserfall Missile.

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1. [redacted] Although this computer was not basically different from that originally designed in Germany during the war, there was apparently considerable improvement made over a period of five years in NII 49.

2. The Wasserfall missile was controlled after the first six seconds of flight by an operator who used a steering device called the Kneuppel. The operator had available to him a telescopic sight which was controlled after the first six seconds of flight by the initial control computer. He could then send signals to the Wasserfall missile via the Kneuppel so as to keep the missile in the center of the sight. Since the firing point was separated from the aiming point by approximately 100 meters, a parallax computer was of necessity included in the command setup. [redacted] The missile was controlled so as to reduce the error between it and the target. When the error was reduced to approximately one-half degree, the initial control computer would be removed from the control system and the operator would steer the missile into the target. The initial trajectory took approximately 30 seconds.

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3. The initial computer satisfied the equation shown below:

$$\gamma_E'' + \frac{t-6}{24}\left[f(\gamma_E - \gamma_Z) + \gamma_E'' + \gamma_Z'\right] = 0$$

γ_E = the desired missile angle (vertical), γ_Z is the vertical target angle.

4. The input target angle, γ_Z, is applied to the computer and subtracted from the output angle, γ_E, to a differential gear system. This difference angle is used to turn a cam. The cam was designed at Peenumuende during World War II and is not known to me. The cam operated the arm of a potentiometer across the voltage source, which was added to the output of a tachometer, which furnished the rate of change of the target angle. This was added through a limiter to the rate of change of missile angle and applied to an amplifier. It should be noted that this value was not immediately furnished in the computer but rose to its full value in six seconds through a potentiometer driven by a constant speed motor. This element in the computer was apparently included to allow a gradually increasing control to the missile after being fired. The amplifier received another input which represented the acceleration of the missile. The acceleration was obtained by a tachometer which furnished a rate voltage. This voltage was applied to a phase advance network whose output was then the acceleration. The amplifier output operated a motor whose angle represents the desired missile angle. This angle was then transmitted to the Kneuppel operator's sight.

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5. In Diagram No. 2 (shown on Page 13 of this report) the schematic of the amplifier used in this computer is illustrated. The input voltage is applied through a relay to the first 6SL7 grid. The relay constitutes a "chopper" operated by a 50 cycle modulating voltage. This voltage is applied through a phase correcting bridge to bring it in phase with the power supply to the amplifier. The output of the 6SL7 is applied to a tuned filter amplified by 6L6's to operate the two-phase induction motor. This amplifier appears to be standard.

25X1 6. [redacted] the design of the computer and amplifier as described above represents the latest improvement [redacted] 25X1

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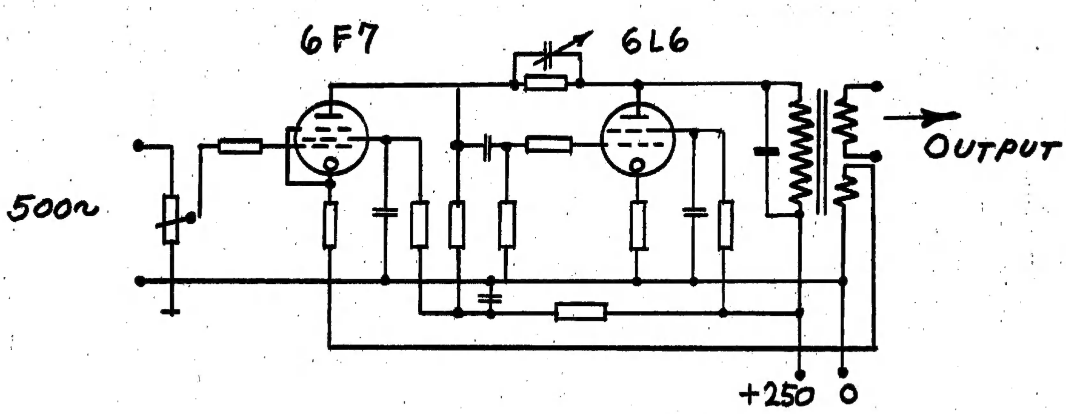

Negative Feed-Back Amplifier
Wasserfall Parallax Computer

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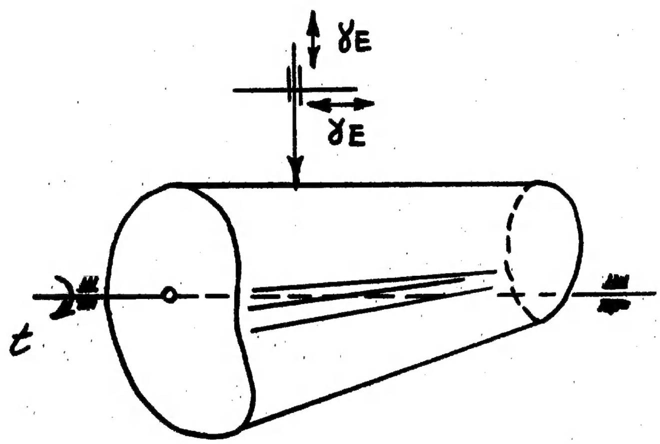

3-DIMENSIONAL CAM
to replace Vertical Angle Computer
WASSERFALL

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